USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2006CA176B

Title: Investigating the role of nitrogen fixation and denitrification in ameliorating deteriorating water quality in a highly eutrophic southern Californian estuary

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Abstract: Estuaries are highly productive ecosystems that support many endangered and commercially important species. In most estuaries, nitrogen limits primary productivity. However, if present in excess, nitrogen can lead to eutrophic conditions, which can adversely affect water and habitat quality. Southern California's estuaries have highly developed watersheds, often resulting in high loads of nitrogen from anthropogenic sources and eutrophication. Our overall goal is to understand the role of two biogeochemical processes, N-fixation and denitrification, that affect processing of N in estuaries and to investigate their response to increased N loads from the watershed. Ultimately, we aim to aid in protecting these important aquatic ecosystems by understanding the constraints and controls that function to balance these two processes and how these processes, especially denitrification, may act to ameliorate the negative effects of eutrophication.

Nitrogen fixation transforms elemental nitrogen (N_2) into ammonium ions (NH_4^+) that can be used by primary producers, and therefore is considered a "new" source of nitrogen. Denitrification transforms

nitrate (NO_3^-) into atmospheric nitrous oxide (N_2O) or nitrogen (N_2), and is therefore a loss of nitrogen from aquatic ecosystems. As these processes either contribute or remove nitrogen from the system, they have the potential to affect water quality and ecosystem health. However, little is known about nutrient dynamics in southern California estuarine environments, and only one study addresses these microbial nitrogen transformations.

We will measure spatial and temporal variability of nitrogen fixation and denitrification and investigate relationships to abiotic/biotic factors in an eutrophic southern California estuary through field surveys and experiments in Upper Newport Bay Ecological Reserve, a large estuary in Orange County, California. This estuary was the focus of a 2-year study funded by the Water resources Center in 1998-99 where we demonstrated its eutrophic status, documented harmful algal blooms, and established the existence of physical/chemical/nutrient gradients that occur from the river entrance to the ocean inlet. These data were used to determine field sites for the proposed work. Field surveys will take place in two seasons (wet and dry) over two years and will include sampling in three areas spanning the spatial gradient of the estuary. Nitrogen fixation and denitrification rates will be measured, as will many site characteristics, to identify correlations between these rates and the abiotic and biotic factors that could be influencing them. We will also conduct three experiments. The first will investigate how sediment characteristics that co-vary with eutrophication affect nitrogen fixation and denitrification rates using a common garden design in the field. The second will quantify the effects of inorganic nutrient enrichment on rates of nitrogen fixation and denitrification in a laboratory experiment using sediment cores from the field. The third experiment will study the effects of the prolific macroalgal mats that dominate upper Newport Bay on sediment nitrogen fixation and denitrification in the field. This combined approach will allow us to understand the factors that control these important processes in the nitrogen cycle that potentially may limit eutrophication.

The proposed research will contribute to basic understanding of nitrogen cycling in these unique and heavily impacted ecosystems, and will determine: spatial and temporal patterns of nitrogen fixation and denitrification rates, correlations of biotic/abiotic factors with rates, and quantitative relationships between factors and rates. It is imperative to understand these processes in California estuaries, since approximately 90% of estuarine and salt marsh systems have already been lost along California's coast. The remaining estuaries are critical habitat and our work will aid in ensuring survival of this vital remaining habitat.
